

# Sub-seasonal to seasonal climate predictions for wind energy forecasting

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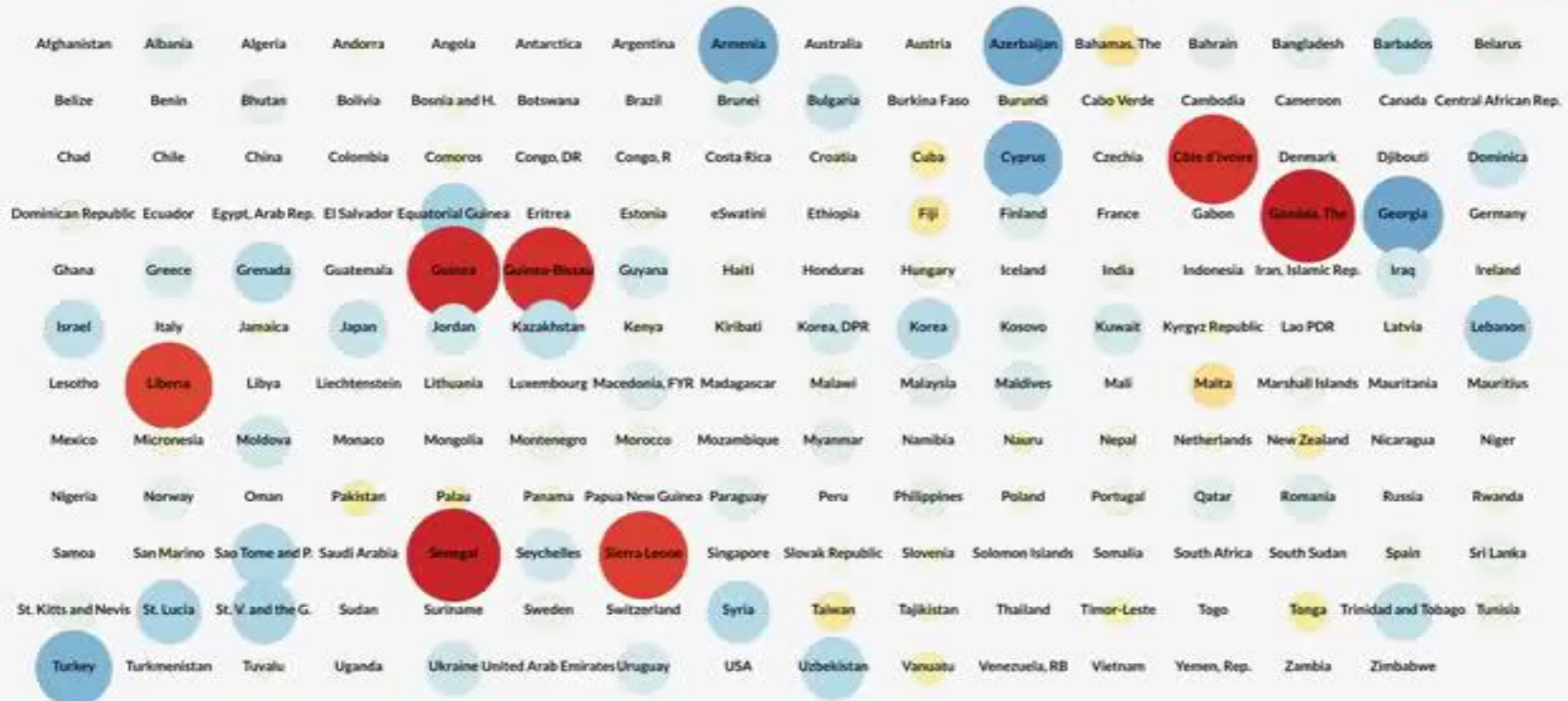
# Weather forecast is a familiar concept ...



# And climate change too, but what about climate variability?



1880



Data Source:  
NASA GISS, GISTEMP Land-Ocean Temperature Index (LOTI), ERSSTv5, 1200km smoothing  
<https://data.giss.nasa.gov/gistemp/>  
Average of monthly temperature anomalies, GISTEMP base period 1951–1980.

Video license: CC-BY-4.0  
Antti Lipponen (@anttilip)

Link: <https://youtu.be/PhbdyNnUliM>

# Context and motivation

- ▶ Energy sector routinely uses weather forecast, especially between day-ahead and one week. Beyond this time horizon, climatological data are used.

Like 15M

Thursday, Aug 30th 2018 1PM 25°C 4PM 26°C 5-Day Forecast

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## Britain's turbines are producing 40% less energy as wind 'disappears' for six weeks across the UK causing record low electricity production

- Britain got 15 per cent of its power from wind last year — twice as much as coal
- Since the start of June, wind farms have been producing almost no electricity
- The 'wind drought' has seen July 2018 be 40% less productive than July 2017
- In the still weather, solar energy has increased by 10% to help cover the drop-off



By [JOE PINKSTONE FOR MAILONLINE](#)

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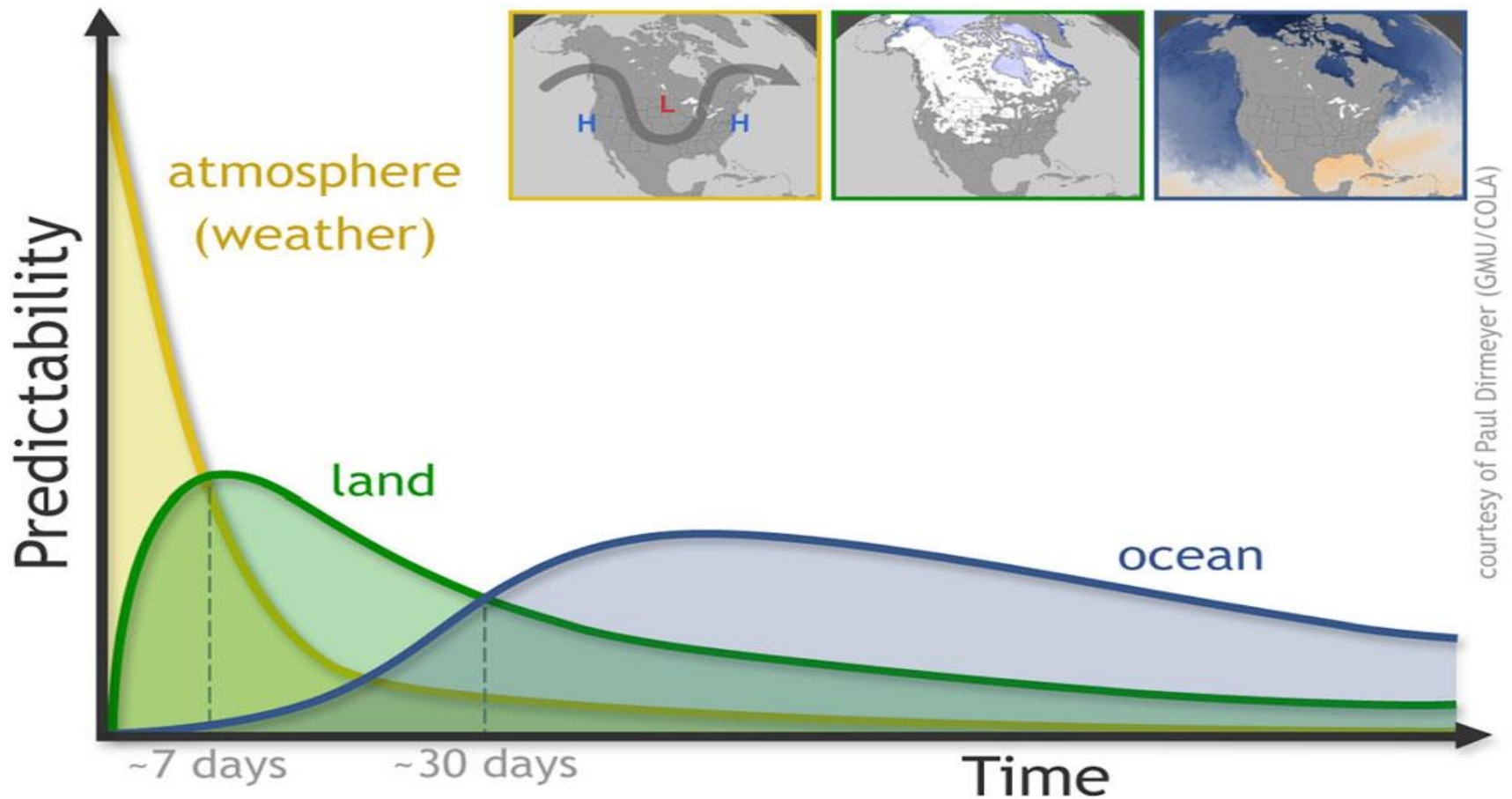


# Predictability

► How can we predict climate for the coming season if we cannot predict the weather next week? Slow components (sea surface temperature, soil moisture, etc.) force the atmosphere.

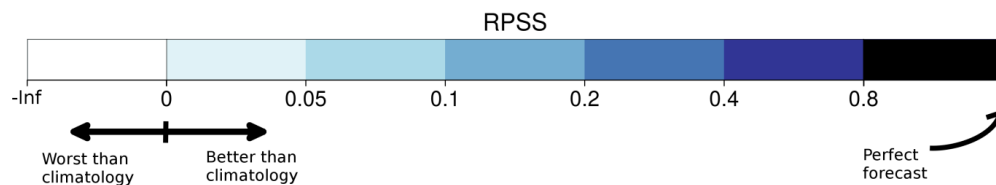
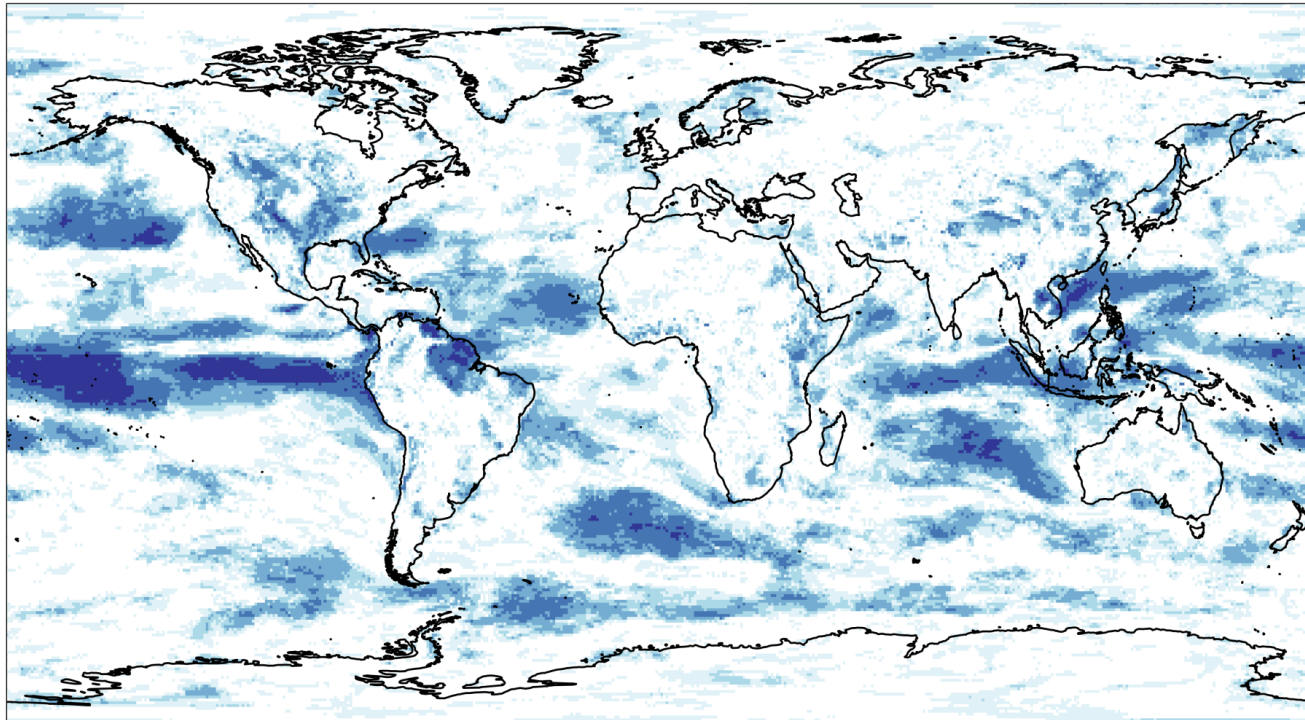


# S2S Forecast range and skill



(Source: Mariotti et al. 2018 )

# S2S skill



Skill assessment  
for DJF (1981-2013)

System: ECMWF S5

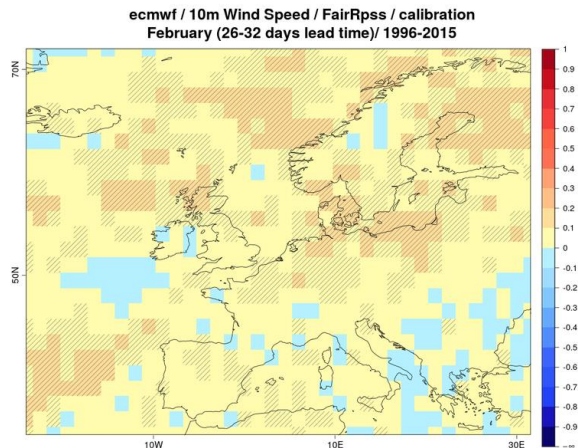
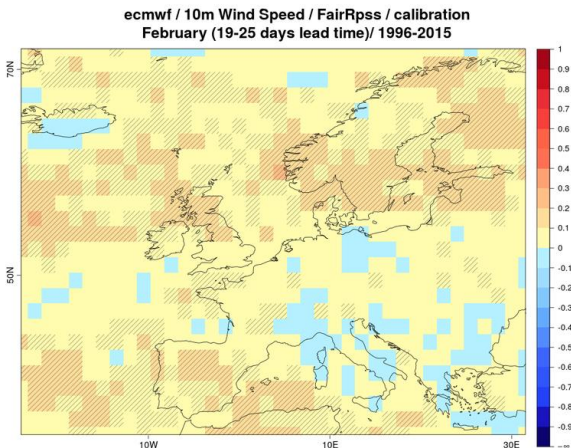
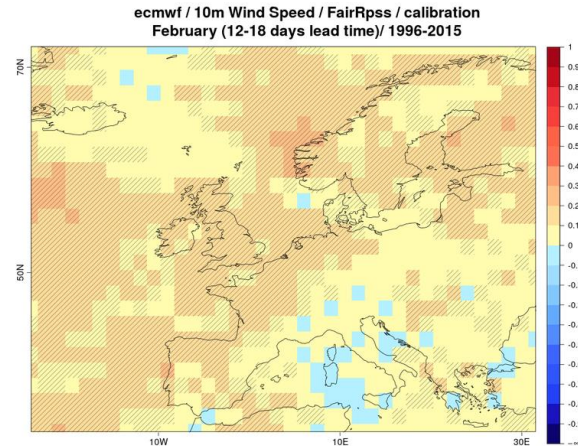
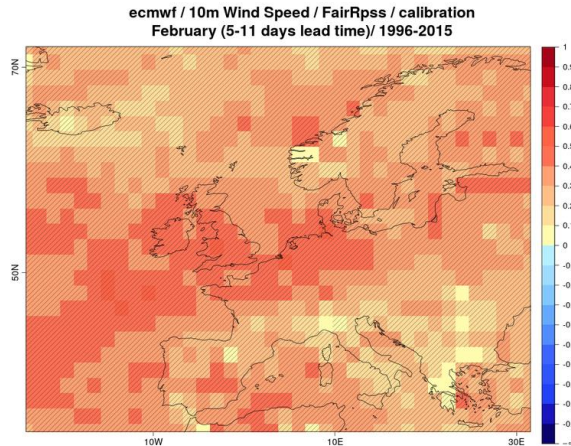
Reanalysis: ERA-  
Interim

Displaying: Ranked  
Probability Skill Score  
[RPSS]

“A prediction has no value without an estimate of forecasting skill based on past performance”



# S2S skill evolution with lead time

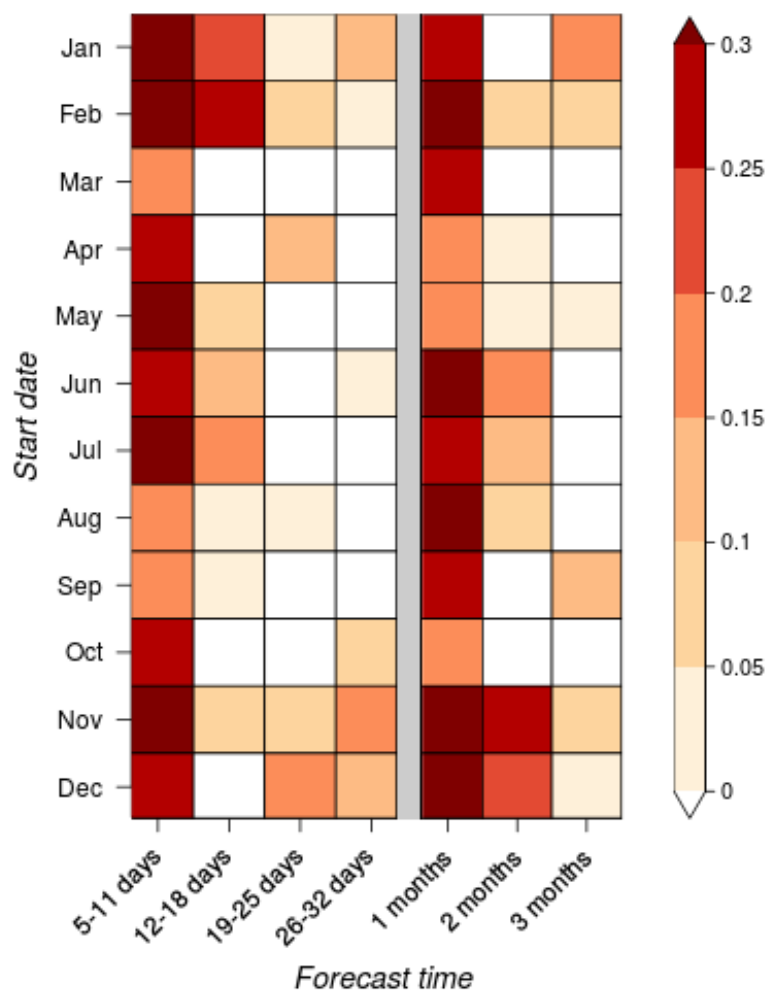


Fair RPSS of 10-m wind speed for the Monthly Prediction System of February (1996-2015).



# S2S skill evolution over the year

FairRPSS of ECMWF 10-m wind speed  
for 1996-2015 over Europe



Reference dataset: Era-Interim

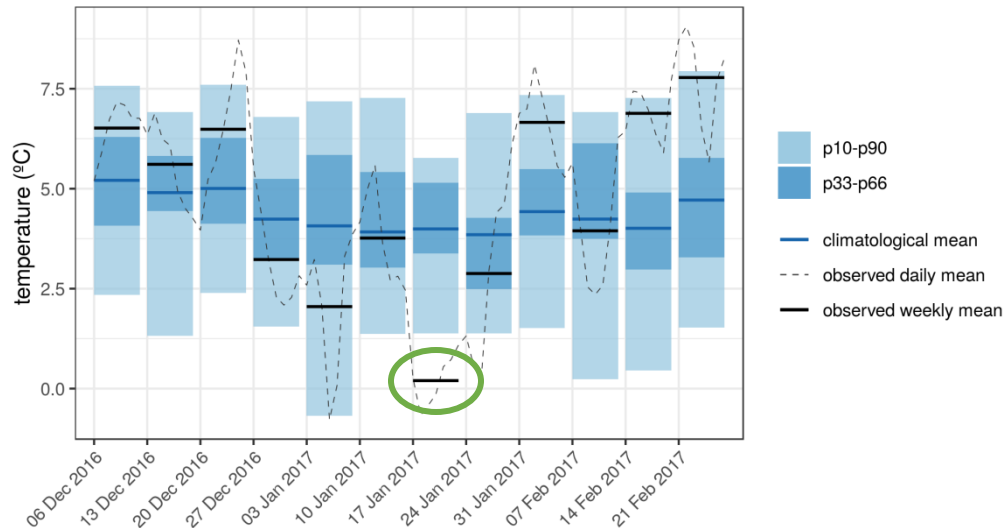


Forecast skill  
characterization in the Fino 1  
area for different start dates  
(Y axis) and forecast window  
(X axis).

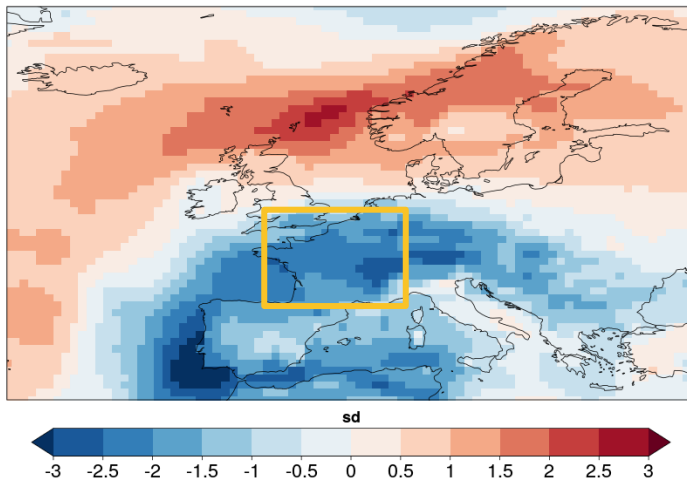


# Cold spell over Europe and lower than usual wind power generation: 17-23/01/2017

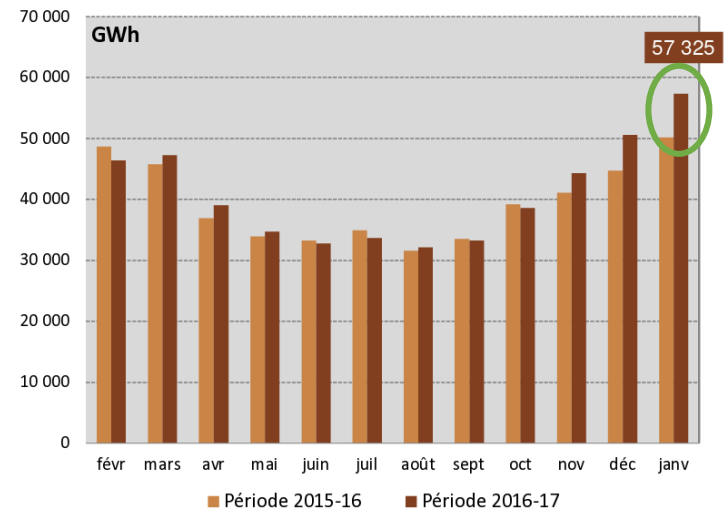
Observed weekly means and climatology



2m Temperature (17-23 Jan)



.. and its consequences in monthly electricity demand in France:



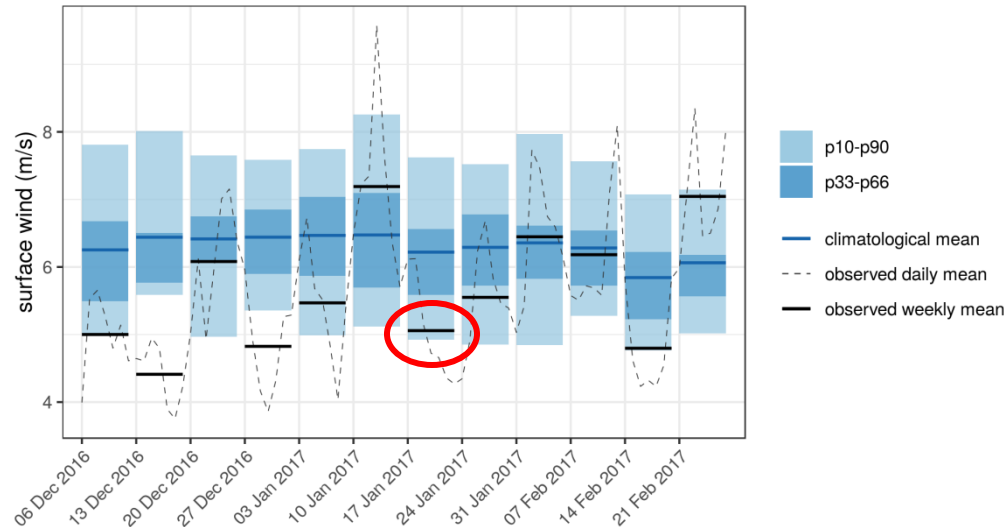
Source: <https://www.rte-france.com>

On 20/01/2017 demand reached a peak high of 94.2 GW (highest since Feb 2012)

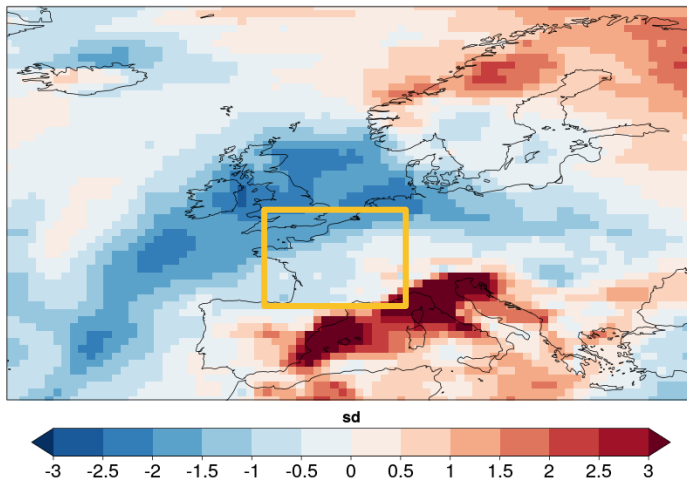
Temperature anomalies for the week 17-23/01/2017. ERA-Interim with respect to climatology (1981-2017).

# Cold spell over Europe and lower than usual wind power generation: 17-23/01/2017

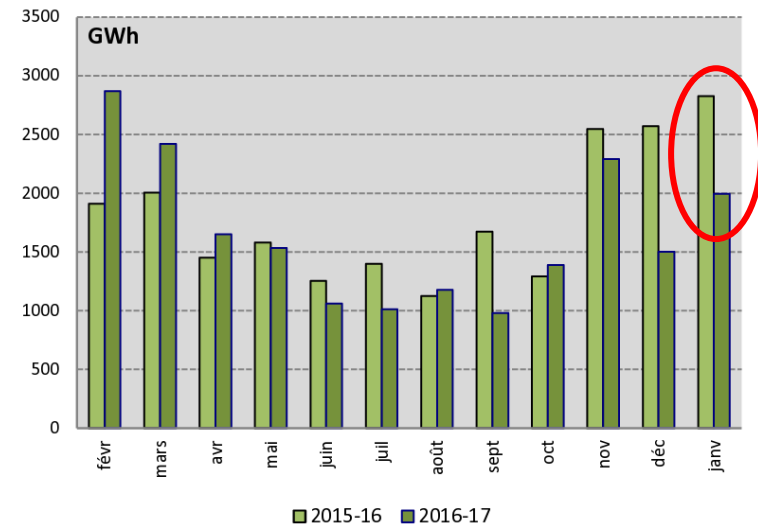
Observed weekly means and climatology



10m wind speed (17-23 Jan)



Monthly wind power generation in France:



Source: <https://www.rte-france.com>

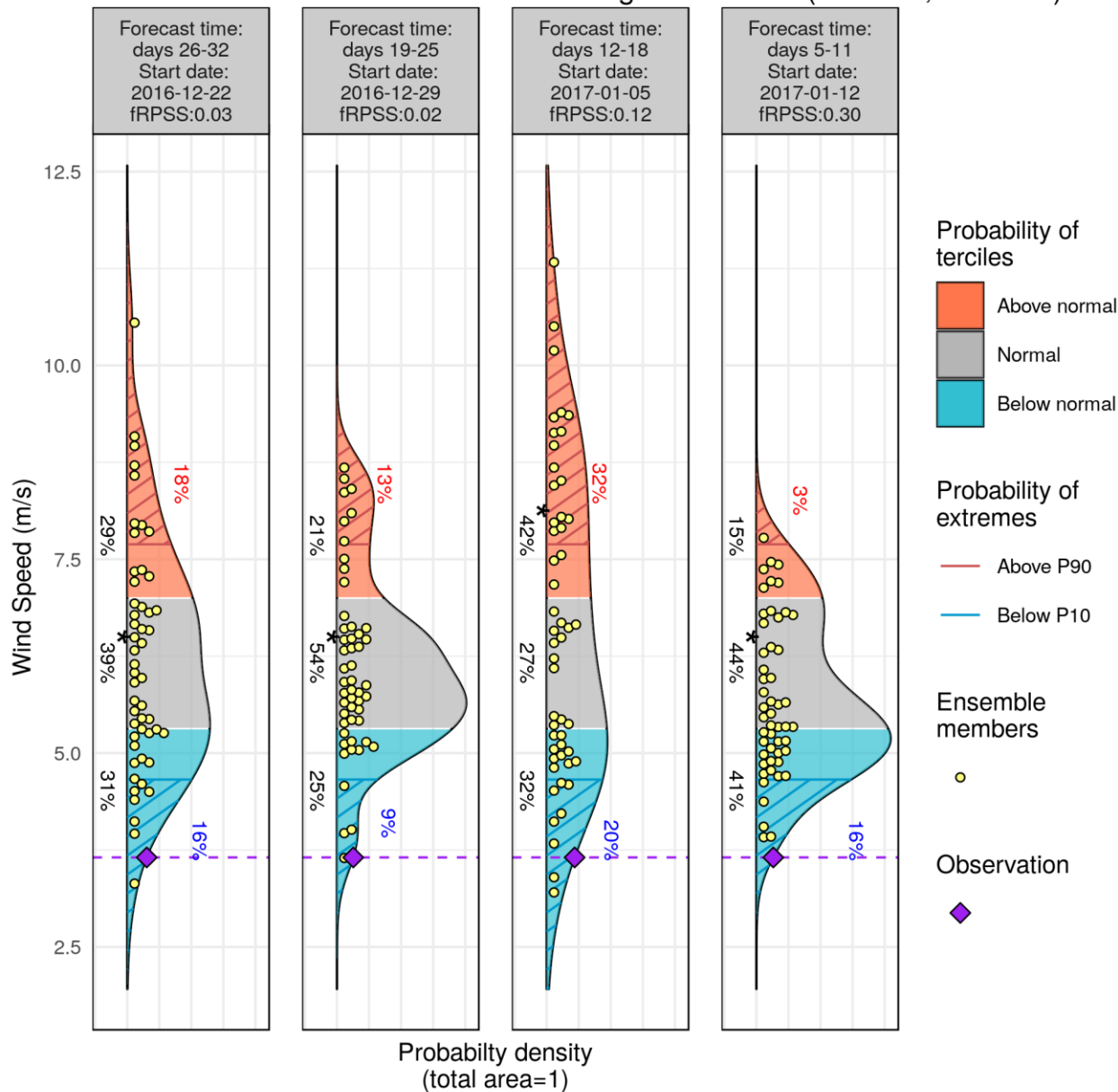
The high demand and low winds led to an increase in energy prices in France (highest since Feb 2012)

Wind speed anomalies for the week 17-23/01/2017. ERA-Interim with respect to climatology (1981-2017).



# Wind speed forecasts

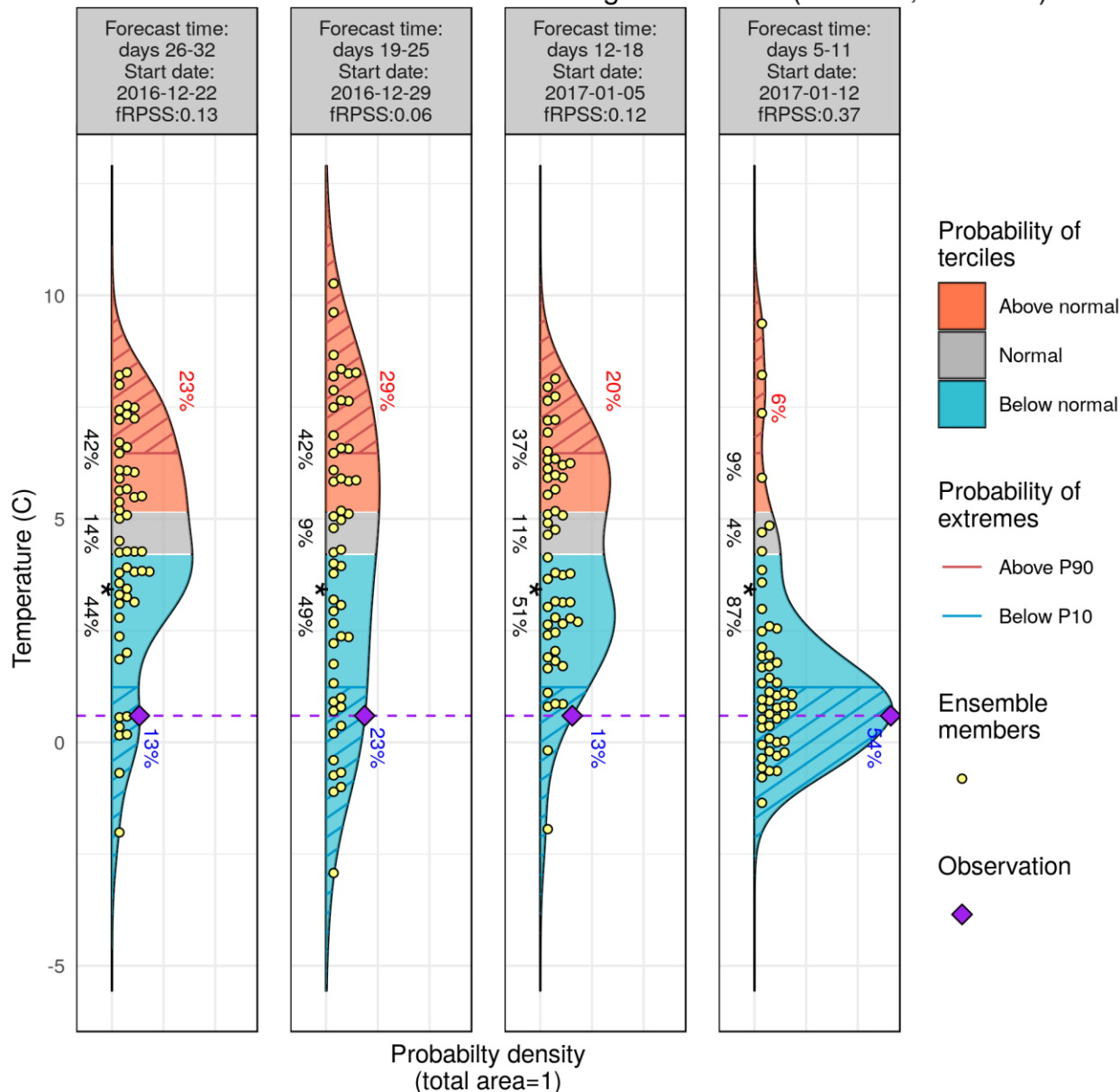
Sub-seasonal forecasts for week starting 2017-01-17 (5W-12E,47N-54N)



System: ECMWF monthly prediction system  
Reanalysis: ERA-Interim  
Bias adjusted –calibrated  
Hindcast: 1996-2015  
Area: 5W-12E/47N-54N

# Temperature forecasts

Sub-seasonal forecasts for week starting 2017-01-17 (5W-12E,47N-54N)



Confidence in anticipating episodes of high electricity demand a few weeks in advance, although less confidence in ensuring that wind energy supply can meet the demand.

System: ECMWF monthly prediction system  
Reanalysis: ERA-Interim  
Bias adjusted –calibrated  
Hindcast: 1996-2015  
Area: 5W-12E/47N-54N

# Conclusions

- ▶ Current methodologies assume that future conditions will be like those of the past. This approach makes impossible to anticipate extreme events that have never happened before.
- ▶ Wind speed forecasted by S2S exhibits predictability some weeks and months in advance in important regions for the energy sector such as the North Sea.

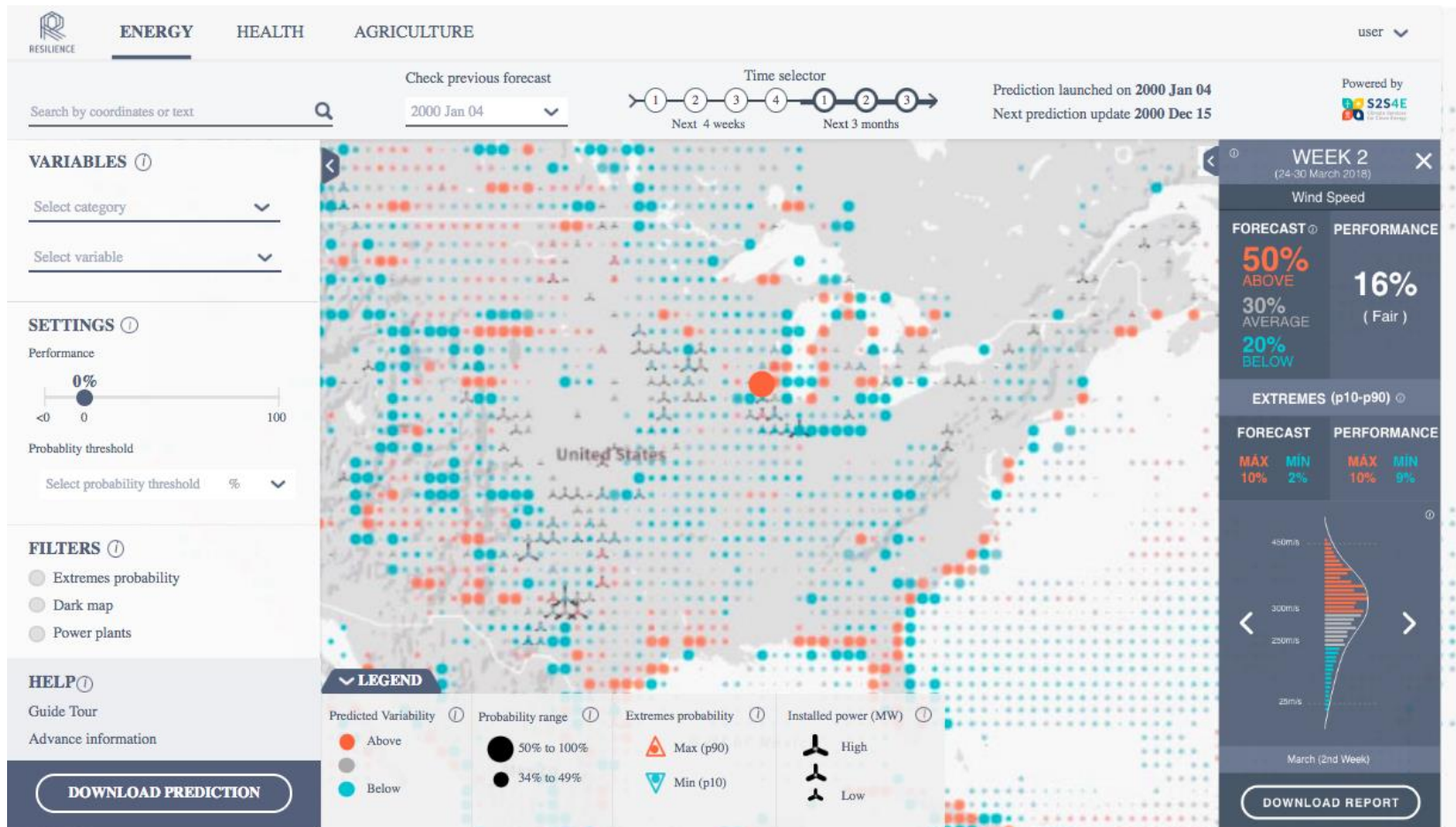
## Future work:

- ▶ From the scientific point of view: to improve the utility of forecasts by incorporating skilful information of the large-scale teleconnection patterns at different time scales and multi-model ensembles.
- ▶ From the user point of view: economic assessment of the case studies.



# Launch event. EUSEW 2019

## 20 June, 20<sup>th</sup> 2019



<http://www.bsc.es/ess/resilience/map.html>

# Supplementary material

# Future work: economic assessment of the case studies

## ► Power Future Settlement Price / France & Germany 2017

*Power future settlement price (EUR/MWh) for week 3 in 2017:*

